The representation of inherent properties

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Abstract: Research on the representation of generic knowledge suggests that inherent properties can have either a principled or a causal connection to a kind. The type of connection determines whether the outcome of the storytelling process will include intuitions of inevitability and a normative dimension and whether it will ground causal explanations.

The inherence heuristic captures a deep characteristic of commonsense thought. As currently formulated, however, it is limited by an extremely cursory characterization of inherent features and patterns. A more robust characterization of the patterns that are grist for the inherence heuristic, as well as how inherent features are represented, would greatly improve the heuristic's ability to predict the types of intuitions that may be generated when explaining a specific pattern. Recent work on the representation of generic knowledge can help provide this more robust characterization.

It is noteworthy that the patterns discussed by Cimpian & Salomon (C&S) involve kinds of things such as boys, girls, and orange juice. This is not an accident. That all coins in my pocket on a given day are copper does not constitute a pattern that can be explained via the inherence heuristic. Such a pattern involves an accidental generalization and thus cannot be explained, much less explained via inherent properties of the coins in my pocket or my pocket. Thus, a minimal condition for the operation of the inherence heuristic is that the pattern be one that involves a nonaccidental generalization and thus is extendable to indefinitely many new instances of the relevant sort (Goodman 1955/1983).

Prasada et al. (2013) provide evidence that our conceptual systems distinguish at least three types of nonaccidental connections between kinds (which contain indefinitely many instances) and properties. Kinds may be characterized by properties that have a principled, causal, or statistical connection to the kind. Each connection type grounds distinct linguistic and nonlinguistic phenomena and reflects a distinct perspective from which we can think about kinds of things. Properties that have a principled or a casual connection to a kind may plausibly be considered inherent properties of the kind when thinking about kinds from a formal or material perspective, respectively, and ground distinct types of inherent thinking.

Properties that have a principled connection to a kind are properties that instances of a kind are understood to have by virtue of their being the kinds of things they are (k-properties). *K-properties* are properties (1) whose presence in instances of a kind support formal explanations – explanations by reference to the kind of thing something is (e.g., Fido has four legs because he is a dog); (2) for which we have normative expectations such that instances of the kind that lack them are judged to be defective or incomplete; and (3) are generally expected to be present in instances of the kind (Prasada & Dillingham 2006; 2009). K-properties are understood to be an aspect of being the kind of thing in question and thus are represented via a formal part–whole relation between the kind and property (Prasada & Dillingham 2009).

Attending to principled connections brings forth the formal dimension of our commonsense conceptions, and we notice formal explanatory relations, as well as the basis for certain normative and statistical expectations. In so doing, k-properties can ground key aspects of inherent thinking identified by C&S. Specifically, the intuition that the pattern is inevitable reflects our expectation that k-properties will generally be present in instances of the kind. K-properties also ground the normative dimension of much inherent thinking – dogs are supposed to have four legs

and the ones that don't have something wrong with them. Note that this is stronger than simply the intuition that something is good or beneficial. We think that it is beneficial for dogs to wear collars, but we don't think there is anything wrong with dogs that don't (Bublitz & Prasada 2013).

Attending to casual connections between kinds and properties brings forth the material dimension of our commonsense conceptions by focusing on the material constitution of the instances of kinds and thus their casual dispositions to behave in one or another manner in appropriate circumstances. Properties that merely have a casual connection to a kind do not ground an expectation that they are generally present in instances of the kind, nor do they ground normative expectations about their presence in instances of the kind (Prasada et al. 2013). As such, though properties that have a casual connection to a kind may be considered inherent properties of the kind and can ground causal explanations of patterns, the intuitions of inevitability and normativity associated with much inherent thinking cannot derive from our understanding of these properties having a casual connection to the kind.

To account for the range of characteristics associated with inherent thinking discussed in the article by C&S, the "storytelling" mechanism must crucially have access to information as to whether a property is considered an inherent property because it is represented as an aspect of being that kind of thing and thus has a principled connection to the kind or if the property is considered an inherent property of the kind because it is casually connected to its material constitution. The type of connection represented between the kind and the property is needed to determine whether the outcome of the storytelling process will include intuitions of inevitability and a normative dimension and whether it will ground causal explanations. Many properties will have both principled and causal connections to a kind (e.g., the four-leggedness of dogs)

C&S are correct that the work on k-properties does not provide an alternative to the inherence heuristic; however, if the present argument is correct, it is a necessary complement to the inherence heuristic. Incorporating the insights from the work on the representation of generic knowledge into the inherence heuristic promises to be a fruitful avenue for future research. Detailed work on the representation of different kind of "habituals" (e.g., *John takes the train to work* vs. *John prefers blonds*) will also likely help inform how the inherence heuristic functions when reasoning about instances rather than patterns. Finally, progress on specifying the scope of the inherence heuristic can likely be made by detailed investigations of the formal characteristics that distinguish kind representations from representations of other types of multiplicities (Prasada et al. 2012).

The developmental and evolutionary origins of psychological essentialism lie in sortal object individuation

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Abstract: Cimpian & Salomon (C&S) present promising steps towards understanding the cognitive underpinnings of adult essentialism. However, their approach is less convincing regarding ontogenetic and evolutionary aspects. In contrast to C&S's claim, the so-called inherence

heuristic, though perhaps vital in adult reasoning, seems an implausible candidate for the developmental and evolutionary foundations of psychological essentialism. A more plausible candidate is kind-based object individuation that already embodies essentialist modes of thinking and that is present in infants and nonhuman primates.

The approach described by Cimpian & Salomon (C&S) presents very promising steps towards a better understanding of the cognitive underpinnings of and interindividual differences in intuitive reasoning and explanation seeking by adults. However, it is less convincing as an explanatory approach for the developmental and evolutionary foundations of essentialist reasoning. One of C&S's main claims – that the so-called inherence heuristic (IH) is the developmental foundation for psychological essentialism – has little plausibility for at least two reasons: *First*, the IH is built on a complex inferential machinery (e.g., the storyteller) that might not be available early in development (and evolution), among other reasons because it appears to rely heavily on linguistic capacities. *Second*, C&S consider psychological essentialism to be a late-developing phenomenon. In their view, essentialism first appears around age 4, when children master verbal tasks that require them to distinguish between essential and superficial features of animals and other objects. In classical transformation and adoption vignettes ("Will a squirrel painted like a raccoon and growing up among raccoons turn out to be a squirrel or a raccoon?"), children from this age base their judgment of the identity of animals exclusively on essential features and neglect superficial ones (Keil 1989).

Unfortunately, however, C&S fail to take notice of earlier cognitive capacities that share some of the essential properties of essentialist reasoning and should thus be considered the ontogenetically and evolutionarily primary forms of psychological essentialism. In particular, even human infants and nonhuman primates engage in a form of object individuation – kind-based or sortal object individuation – that embodies essentialist modes of thinking. Conceptually, *sortal object individuation* is the capacity to conceive of objects as objects of certain kinds X, Y, Z (dogs, cats, bananas…) by using sortal concepts ("X," "Y," "Z" – "dog," "cat"…) that supply criteria for individuation ("How many Xs are here?") and identity ("Is this the same X that I saw before?"). Empirically, this capacity has been studied by confronting infants and apes with, say, a box into which an X enters at time 1, followed at time 2 by a Y coming out of the box. Subjects' numerical expectations as to how many objects are in the box are then measured, as indexed in looking and searching behavior: If they think of the objects as objects of distinct kinds that cannot turn into each other, they should expect that there must be (at least) one object, the X, still in the box.

Basic versions of such tasks in which an X (e.g., a banana piece) and a Y (e.g., a carrot piece) are used that differ both in essential and in superficial properties are mastered by human infants from around 12 months (Xu 2007) and by nonhuman primates (Mendes et al. 2008; 2011; Phillips & Santos 2007). Because these findings – due to the confound between essential and superficial feature differences – remain somewhat inconclusive regarding the question of whether infants and primates really solve these tasks by using sortal concepts and essentialist reasoning, we recently designed a modified version of individuation tasks. This version was inspired by the classical verbal essentialism tests and enabled us to deconfound essential and superficial property differences: Infants and nonhuman primates saw one object with surface features SF1 enter into a box at time 1 and then at time 2 an object with different surface features SF2 coming out of the box. In fact, however, the object with SF1 was identical to the object with SF2. (For example, in the infant studies, there were stuffed toy animals that could be turned inside out, appearing as a bunny in one form and as a carrot in the other.) The crucial variation was whether the subjects were aware of this. The results showed that those infants and apes that were unaware of the dual identity of the object took the superficial feature differences as diagnostic for their numerical expectations:

They thought that there still must be an object in the box – as indicated by their significantly longer searching in the box as compared with events where the superficially identical object with SF1 appeared at time 2. In contrast, those infants and apes that knew about the object's dual identity disregarded the superficial feature differences, did not expect a second object in the box, and did not search differently in the two events. That is, given the requisite background knowledge, infants and apes disregarded the superficial feature differences in very much the same way that older children disregard the superficial feature differences between a normal squirrel at time 1 and a raccoon-looking squirrel at time 2 (after it has been painted etc.) when it comes to the question of the animal's identity (Cacchione et al. 2013; submitted).

So, what these studies – together with other infant studies (Newman et al. 2008) and primate work (Phillips et al. 2010) – suggest is that basic forms of psychological essentialism appear to be present much earlier in development and evolution than assumed by C&S. And this has important implications for the type of account C&S are putting forward – suggesting the following slightly different picture:

1. The developmentally and evolutionarily primary forms of psychological essentialism lie in sortal object individuation: Distinguishing between essential properties of an object that determine criteria of identity and countability, and merely superficial features that do not, is already the simplest form of essentialist reasoning. From an evolutionary perspective, such a basic distinction between deep and superficial properties seems to be a fundamental design feature of higher cognition given the need to distinguish between differences in essential (and therefore identity-preserving) properties and merely superficial properties in so many domains (e.g., regarding natural food items that constantly change form and color, or regarding conspecifics that change appearances by growing and decaying).

2. Out of this general capacity, then, more specific forms of conceiving of the (essential vs. merely superficial) properties that are relevant for a given kind of object emerge, possibly based on some domain-specific sensitivities to which kinds of properties might be relevant for which type of object.

3. Over development, subsequently, the IH – as a broader and more complex cognitive tendency– might emerge out of and hook onto this developmental basis.

Inherence-based views of social categories

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Abstract: Children adopt an inherence-based view of some social categories, viewing certain social categories as reflecting the inherent features of their members. Thinking of social categories in these terms contributes to prejudice and intergroup conflict. Thus, understanding what leads children to apply inherence-based views to particular categories could provide new direction for efforts to reduce these negative social phenomena.

Cimpian & Salomon (C&S) present a compelling description of how a fundamental cognitive bias – to explain observed patterns as resulting from the inherent features of the involved entities – underlies an impressive range of cognitive and social phenomena. From a developmental perspective, it is easy to see how such a heuristic might be useful in early conceptual development. By allowing children to expect stability in their environment, the inherence heuristic simplifies children's immense learning challenge. Yet, as discussed by the authors, the inherence heuristic may also have deleterious consequences, particularly when